PAPERS AND SHORT REPORTS

Risks of intracranial haematoma in head injured adults

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Abstract

A study was conducted to estimate the risk that an adult (age 15 or over) will develop a surgically significant intracranial haematoma after a head injury. Two simple features were used that can be recognised by clinicians with minimal training: a skull fracture and the conscious level. The risks were calculated from samples of 545 patients with haematomas, 2773 head injured patients in accident and emergency departments, and 2783 head injured patients in primary surgical wards. With radiological evidence of skull fracture and any impairment of consciousness (including disorientation) one patient in four in an accident and emergency department or primary surgical ward will develop a haematoma. With no skull fracture and preserved orientation the risk to a patient in an accident and emergency department is one in 6000.

The use of risk levels as a basis for decision making about head injured patients may result in fewer haematomas being detected too late and savings of resources by reducing the admission and investigation of low risk categories of patients.

Introduction

A traumatic intracranial haematoma is a major cause of preventable mortality and morbidity after head injury. That the earlier detection of haematomas may lead to improved results[1-3] highlights the need both to predict which patients are likely to develop a haematoma and to detect this complication before the brain becomes irreversibly damaged. Yet this complication develops in a very few of the large numbers of patients who attend accident and emergency departments, and is uncommon even in those who are admitted to primary surgical wards in general hospitals.

Although traditional criteria emphasise deteriorating responsiveness as the classical clinical feature of a haematoma, the objective should be to identify patients at risk before deterioration takes place. This is necessary in order to decide which patients need admission to hospital simply for observation and which have such a high risk that referral for immediate scanning by computed tomography (CT) is justified without this period of observation.

Patients who develop a haematoma commonly have either a skull fracture or depression of consciousness when they first present to a hospital; a haematoma seldom develops in the absence of a fracture except in children.[4] The level of risk associated with these two features has not previously been calculated, and we therefore set out to do this.

As a basis for calculating the risks we analysed the frequency of occurrence of skull fracture and impaired consciousness in attenders at accident and emergency departments, in patients admitted to primary surgical wards, and in patients with surgically verified intracranial haematomas. The yearly number of patients with these different features per million population was estimated as a basis for considering the advisability and feasibility of routine CT scanning for the early detection of an intracranial haematoma.

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Sources of data

The study was confined to adults (age 15 or over) in three groups of head injured patients.

Attenders at accident and emergency departments (see table I)—Three series provided data. A sample of 1752 patients who had attended accident and emergency departments in Scotland during 1974[5] yielded information about both skull fracture and whether or not the patient was talking sensibly (verbal score 5 on the Glasgow coma scale). Similar information was available for 663 adult patients who attended the department at the Glasgow Royal Infirmary[6] and for 358 patients studied in Teesside.[7]

Admissions to primary surgical wards (see table II)—There were four sources of information on patients in primary surgical wards.

Of 1181 patients in a study of primary surgical wards throughout Scotland in 1974, 746 fulfilled the criteria for inclusion in our study.[8] Similar data were obtained from 1151 head injured patients admitted direct to the Edinburgh Head Injury Unit.[9] A total of 768 of 918 admissions to a Glasgow teaching hospital[10] and 118 adult admissions to primary surgical wards in Teesside[7] were also included.

TABLE I—*Frequency of features in 2773 adult patients from three samples attending accident and emergency departments*

	Teesside (1974)[7]	Strang *et al* (1974)[5]	Swann *et al* (1981)[6]	Total (%)
No skull fracture:				
Orientated	347	1587	606	2540 (91·6)
Not orientated	6	135	43	184 (6·6)
Skull fracture:				
Orientated	4	11	11	26 (0·9)
Not orientated	1	19	3	23 (0·8)
Total (%)	358	1752	663	2773 (100·0)

TABLE II—*Frequency of features in 2783 adult patients from four samples admitted to primary surgical wards*

	Scottish head injury management study (1974)[8]	Galbraith *et al*[10]	Teesside (1974)[7]	Mendelow *et al*[9]	Total (%)
No skull fracture:					
Orientated	565	504	107	819	1995 (71·7)
Not orientated	141	194	8	213	556 (20·0)
Skull fracture:					
Orientated	23	40	0	59	122 (4·4)
Not orientated	17	30	3	60	110 (4·0)
Total (%)	746	768	118	1151	2783 (100·0)

Operated traumatic intracranial haematomas (see table III)—In a prospective study of patients who underwent operation for an acute traumatic intracranial haematoma in our unit over seven years[3] data were collected concerning the presence or absence of skull fracture in the *x* ray films at the referring hospital, as well as the level of consciousness at the time of admission there. During the period of this study head injured patients in the west of Scotland who were suspected of having a traumatic haematoma were assessed and observed in accident and emergency departments and in primary surgical wards before referral to the regional centre for operation. There were 545 adult patients with complete information available.

TABLE III—*Frequency of features in 545 adult patients with traumatic intracranial haematoma*

	No skull fracture		Skull fracture		Total
	Orientated	Not orientated	Orientated	Not orientated	
No (%) of patients	29 (5·3)	104 (19·1)	55 (10·1)	357 (65·5)	545 (100·0)

TOTAL POPULATION AT RISK

We estimated the number of head injured patients who had attended accident and emergency departments or been admitted to primary surgical wards in the west of Scotland during the seven years over which the haematomas had been collected. These yearly estimates were based both on the Scottish head injury management study[5] and on the Scottish mortality records.

Results

RELATIVE RISKS

Relative risk is defined as the risk that a patient who has one or both of the features studied will develop an intracranial haematoma as compared with a patient who has neither. The frequency distribution of these features in attenders at accident and emergency departments and patients admitted to primary surgical wards differed considerably from that in the haematoma series (tables I-III). Patients without a fracture and with no loss of orientation accounted for only 5% of the patients with a haematoma but for 92% of patients in accident and emergency departments. On the other hand, 66% of patients with a haematoma had a skull fracture and were initially not orientated, whereas such patients made up less than 1% of the accident and emergency department population. A patient with a fracture who was not orientated when seen initially thus had a risk of 92% over 5% times 66% over 1%—namely, 1400 (770 to 2400) times as high as a patient who had no fracture and was orientated. (Relative risks were calculated from the actual numbers of patients rather than the rounded percentages given here. They are quoted to two significant figures and followed in parentheses by approximate 95% confidence limits.) For patients with only a fracture or only impairment of consciousness in the accident and emergency department the corresponding figures were × 190 (100 to 340) and × 50 (32 to 77) respectively. In the primary surgical ward series, on the other hand, the risks relative to patients without a fracture or disorientation when admitted to hospital were: for those with both a fracture and loss of orientation × 220 (140 to 340); for those with a fracture but orientated × 31 (19 to 51); and for those without a fracture but with loss of orientation × 13 (8 to 20) (fig 1). Positive features therefore exerted a greater influence on the relative risk in the accident and emergency series than in the primary surgical ward series.

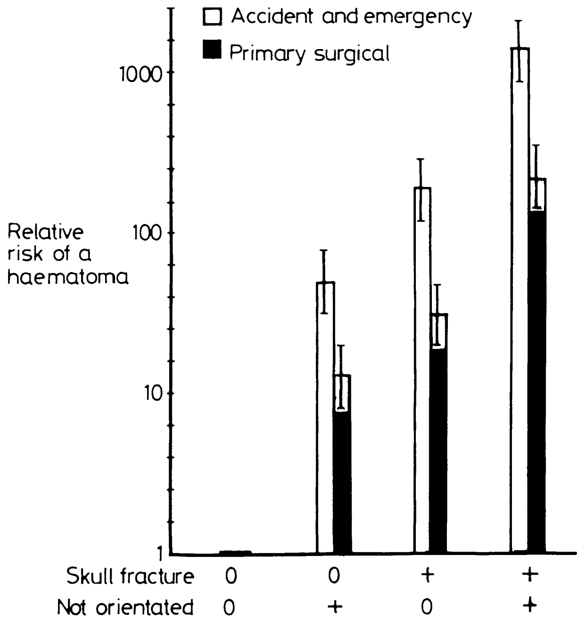

FIG 1—Relative risks of haematoma compared with patient with no skull fracture and orientated (0,0), whose risk is represented as 1. Risks for patients in accident and emergency departments or primary surgical wards shown as separate bars, with approximate 95% confidence intervals.

ABSOLUTE RISKS

The absolute risk is expressed as the frequency of a traumatic haematoma in the total number of patients with a given set of features in the referral population—that is, accident and emergency or primary surgical ward. The patients with operated haematomas represented almost all of the adult patients who underwent operation for traumatic intracranial haematomas in the west of Scotland over seven years. The total accident and emergency and primary surgical ward populations at risk in the west of Scotland in the same period were estimated as follows.

Accident and emergency—The attendance rate with head injury at accident and emergency departments in Scotland in 1974 was 1778 per 100 000 a year,[7] of which 58% was accounted for by adults. The population of the west of Scotland catchment area from which the patients with haematomas were referred is 2·7 million, and the annual attendance was estimated for each year. Over the seven years of the haematoma series (1974-80) this came to 212 025 adult attenders with head injury, allowing for an increase in such patients in the accident and emergency departments each year.

Primary surgical ward—Analysis of Scottish mortality record data for admissions to primary surgical wards with head injury showed that there had been a yearly increase in numbers since 1974 and that in the west of Scotland the number of adult admissions over the seven years was 41 006.

Estimation of the risk of an intracranial haematoma, in absolute terms, requires data about the total number of adult head injured patients in the different groups seen in accident and emergency departments and admitted to primary surgical wards in the region in the same period. Because complete data were available in only 545 of the 610 patients with a haematoma, the total accident and emergency and primary surgical ward estimates for this period were each reduced by a corresponding factor, assuming that the missing cases were randomly distributed. By using these corrected figures as a base (189 432 for accident and emergency, 36 637 for primary surgical ward) the frequencies of the four different kinds of features in accident and emergency and primary surgical ward patients during the period of analysis were estimated from their frequencies in the samples in tables I and II, and are given below.

Accident and emergency patients (table IV)—By far the largest group of patients were those with no skull fracture and no disorientation. The absolute risk of haematoma ranged from one in 5983 in this group to one in four in patients with both features.

TABLE IV—*Absolute risk of haematoma for adult patients in accident and emergency departments with estimated number of patients in different groups (1974-80)*

	No (%) of patients with haematomas n (h)	No (%) of attenders at accident and emergency departments n (a)	Absolute risk in accident and emergency population n (h): n (a)
No skull fracture:			
Orientated	29 (5·3)	173 515 (91·6)	1:5983
Not orientated	104 (19·1)	12 570 (6·6)	1:121
Skull fracture:			
Orientated	55 (10·1)	1 776 (0·9)	1:32
Not orientated	357 (65·5)	1 571 (0·8)	1:4
Total (%)	545 (100·0)	189 432 (100·0)	

Primary surgical ward patients (table V)—The incidence of a haematoma in primary surgical ward patients with neither feature was one in 906. This is a higher incidence than in the comparable group in the accident and emergency series, presumably because many similar patients had been discharged and not admitted. With both features present the absolute risk was one in four (the same as in the accident and emergency series, presumably because almost all patients with both a fracture and loss of orientation had been admitted). The rank order of risks was the same as for relative risks.

To evaluate the potential impact on resources we estimated the number of patients in each category for one average year and the number who would develop a haematoma per million population (table VI; fig 2). Thus there would be 86 patients per million a year with a skull fracture and alteration in consciousness. When this yearly rate is related to the actual risk, it is clear that these would yield 22 haematomas per million population (a 1:4 risk) (fig 2).

TABLE V—*Absolute risk of haematoma for adult patients in primary surgical wards with estimated number of patients in different groups (1974-80)*

	No (%) of patients with haematomas n (h)	No (%) of admissions to primary surgical wards n (p)	Absolute risk in primary surgical ward population n (h): n (p)
No skull fracture:			
Orientated	29 (5·3)	26 263 (71·7)	1:906
Not orientated	104 (19·1)	7 320 (20·0)	1:70
Skull fracture:			
Orientated	55 (10·1)	1 606 (4·4)	1:29
Not orientated	357 (55·5)	1 448 (4·0)	1:4
Total (%)	545 (100·0)	36 637 (100·0)	

TABLE VI—*Yearly incidence (per million) of adult head injuries and number of haematomas in each group (corrected to two significant figures and whole numbers)*

	Attenders at accident and emergency departments (per million)	Admissions to primary surgical wards (per million)	No of haematomas (per million)
No skull fracture:			
Orientated	10 000	1 600	2
Not orientated	740	430	6
Skull fracture:			
Orientated	110	95	3
Not orientated	93	86	22

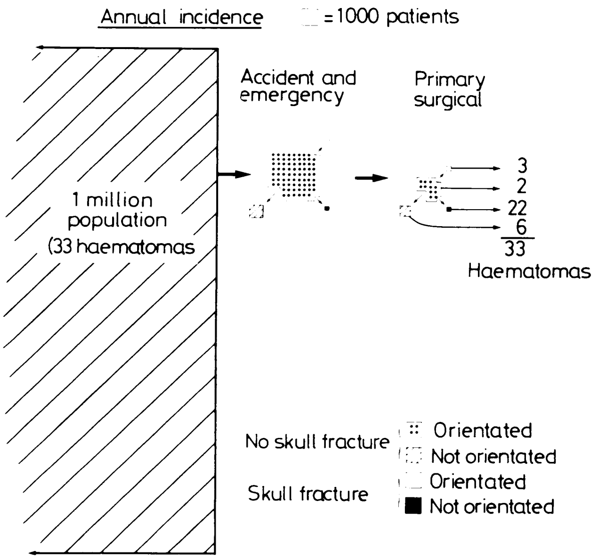

FIG 2—Size of populations with each set of features, and number of haematomas that could be expected each year from each group per million in general population.

Discussion

There is clearly a consistent rank order of risks of a patient developing a haematoma with the presence of skull fracture or impairment of consciousness or both. When both features are present the risk is several orders of magnitude greater than if neither is present. In calculating these risks we aggregated data from several sources and there were therefore opportunities for inaccuracy. Nevertheless, the data from which we derived the frequencies of the features in the different groups were obtained from specifically designed data collection forms, on which were recorded the information for each patient in the various original studies. The composition of these different series was closely similar, thus enhancing the validity of our results.

The actual levels of risks were calculated assuming that our series[3] included all the surgically significant haematomas that occurred in our region over seven years. Operations on head injured patients are very occasionally undertaken in some of the most outlying hospitals in this region, but in one of the largest of these only two traumatic haematomas were evacuated in seven years.[11] Furthermore, we allowed for an increase since 1974 in the total number of head injured patients presenting to hospitals in the west of Scotland, a trend which is supported by recent figures: the data therefore cannot be an overestimate of the frequency of haematomas. Indeed they underestimated the frequency of haematomas detected by CT scanning in head injured patients, since the haematoma series included only cases that required surgical evacuation. Many lesions seen on CT scanning were managed conservatively and were excluded from the study. Our data therefore relate to surgically significant haematomas only. The rate of 36 patients of all ages with such a surgically significant haematoma per million population a year observed over the seven years of our study was closely comparable to the overall incidence in two other Scottish neurosurgical units[12] and the figure of 77 a year in a population of two million in Merseyside (J J Jones, R V Jeffreys, personal communication).

Other studies of patients at risk of developing a traumatic intracranial haematoma have not analysed separately their clinical and radiological characteristics. Totten and Buxton reported that of some 5000 head injured patients admitted for "precautionary reasons" to the Birmingham Accident Hospital, only one patient in their series could have benefited from admission[13]; and that patient was sent home with a missed skull fracture and subsequently died of cerebral oedema. Mendelow *et al* also drew attention to the low risk of a haematoma in patients without a skull fracture who were orientated.[9] Similarly, Galbraith and Smith reported that only 4% of patients who developed a haematoma had neither a skull fracture nor neurological signs at the time of their first admission to hospital, a finding confirmed in this study.[4]

Our findings reaffirm the evidence of these other studies that the presence or absence of a skull fracture is a crucial piece of information in the management of head injured patients. While we sympathise with the efforts of the Royal College of Radiologists to reduce the number of negative skull *x* ray examinations performed in casualty departments,[14] our evidence indicates that skull radiography should continue to be part of the management of these patients. Practical guidelines indicating which head injured patients should be examined radiologically are urgently needed; these should be reasonably liberal and should aim at minimising the possibility of failing to take radiographs of a patient with a fracture.[15]

Our study provides a basis for evolving policies for managing head injured patients which will ensure that the maximum resources are allocated to minimising avoidable mortality and morbidity. This can be achieved by reducing the total number of head injured patients admitted to hospital but at the same time providing adequate facilities for the urgent scanning of patients at greatest risk. Our study identifies three populations of head injured patients: (1) a large number who have an extremely low risk of a haematoma; (2) a population made up of two subgroups in whom the risk of haematoma is intermediate; (3) a small minority of patients in whom the risk is extremely high.

Adult head injured patients with no skull fracture who are fully orientated at the time of examination have an extremely low risk of a haematoma, even if there is a history of amnesia. We estimate that half a million such patients attend hospital in Britain a year and that 80 000 are admitted. If such adults were sent home from accident and emergency departments there would be major savings with minimal risk.

Patients with a skull fracture who are orientated, or patients without a fracture who are confused, have intermediate levels of risk. Clearly these patients should be observed in hospital. Although almost one third of patients with a significant traumatic haematoma come from these groups, it is debatable whether they should all be referred for CT scanning on a routine basis. If scans were carried out on all patients with a skull fracture who were orientated, only 3% would show surgically remediable lesions; however, this figure is comparable to the return for routine CT scanning of patients with dementia[16] or with epilepsy.[17] Further work is needed to discover if patients at particularly high risk in these groups can be identified at the time of admission.

Patients with a skull fracture who are not orientated have a one in four risk of developing a significant intracranial clot. After any necessary initial resuscitation all such patients should be referred without further delay for CT scanning. This should not unduly overload existing facilities, because we estimate that there are only nine such patients per 100 000 population a year. This would result in fewer than two scans a week in a neurosurgical unit serving a population of one million. It would yield an operable intracranial clot once every two weeks and ensure the early diagnosis of almost two thirds of all traumatic intracranial haematomas.

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MEDICINES BREEDING FLESH—There are many things diligently to be observed in the cures of wounds and ulcers, which incur and hinder that the cure cannot be speedily done, nor the separated parts reduced to their natural state. *Viz* Fluxes of blood, inflammation, hardness, pain, and other things besides our present scope. Our present scope is, to shew how the cavity of ulcers may be filled with flesh. Such medicines are called *Sarcoticks*. This, though it be the work of nature, yet it is helped forward with medicines, that the blood may be prepared, that it may the easier be turned into flesh. These are not medicines which breed good blood, nor which correct the intemperature of the place afflicted, but which defend the blood and the ulcer itself from corruption in breeding flesh. For nature in breeding flesh produceth two sorts of excrements, viz scrosus humours, and purulent dross. Those medicines then which cleanse and consume, these by drying are said to breed flesh, because by their helps nature performs that office. Also take notice that these medicines are not so drying that they should consume the blood also as well as the sanies, nor so cleansing that they should consume the flesh with the dross. Let them not then exceed the first degree unless the ulcer be very moist. Their difference are various, according to the part wounded, which ought to be restored with the same flesh. The softer then, and tenderer the place is, the gentler let the medicines be. (Nicholas Culpeper (1616-54) *The Complete Herbal*, 1850.)